MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2018/2019

DET5088 – ANALOG ELECTRONICS 3

(Diploma in Electronic Engineering)

29 MAY 2019
9:00 AM –11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 pages excluding the cover page and appendix.
2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 marks]

(a) Describe the function on operational amplifier. (3 marks)

(b) Sketch an ideal voltage follower and explain its main function. (4 marks)

(c) Explain the circuit diagram of an instrumentation amplifier. (3 marks)

(d) Distinguish between the passive filter and active filter. (4 marks)

(e) Describe any **FOUR (4)** advantages of an active filter. (8 marks)

(f) Thermal drift is one of the error component in the practical operational amplifier. Describe how to minimize this drift to reduce the error in the output voltage. (3 marks)

QUESTION 2 [25 marks]

(a) Based on the simple block diagram shown in Figure 1, briefly explain the signals for V_{in}, A,B, C and V_{out} with aid of its waveform respectively. (9 marks)

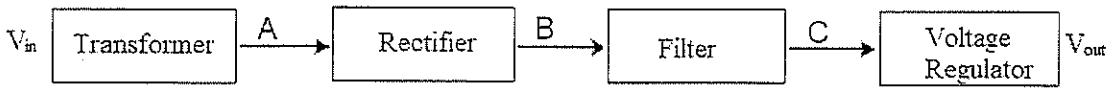

Figure 1

(b) Briefly explain the frequency stability in an oscillator. Then, describe the relationship between the quality factor and the frequency stability. (6 marks)

(c) Briefly explain the non-linear circuit. (4 marks)

(d) Sketch the diagram of a double-bounded comparator and explain its advantages over the bounded comparator. (6 marks)

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QUESTION 3 [25 marks]

(a) Figure 2(a) shows an amplifier circuit with R_f = 3.3 kΩ and C = 1 nF, while Figure 2(b) shows the input waveform of the amplifier circuit.

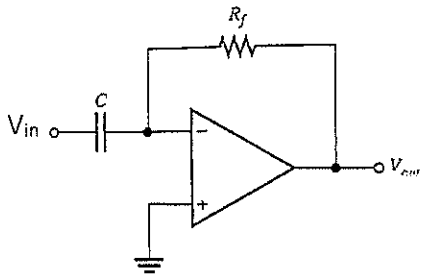

Figure 2(a)

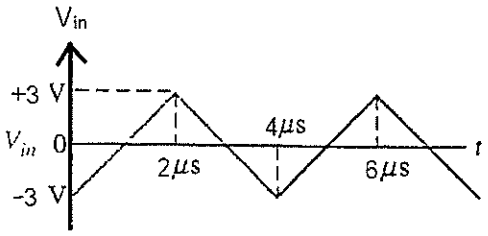

Figure 2(b)

i) Identify the type of op-amp application in Figure 2(a) (1 mark)

ii) Calculate the output voltage. (5 marks)

iii) Sketch the output voltage waveform. (4 marks)

(b) Determine the frequency for voltage gain, $|A|$ = 0.5 of a Butterworth 5th order low pass filter with cutoff frequency, f_c = 20 kHz. (3 marks)

(c) The voltage transfer function of a 2-pole filter is given as,

$$H(S) = \frac{\frac{50000}{s}}{\frac{10000}{s} + 200 + s}$$

i) Determine the value of DC voltage gain (K), quality factor (Q) and oscillation frequency (ω_o) (8 marks)

ii) Identify the type of the filter based on the transfer function. (1 mark)

(d) When the AC input voltage of a power supply changes, the input to the voltage regulator decreases by 4 V causing the output voltage of the regulator decreases by 0.2 V. The nominal output is 20 V. Determine the line regulation. (3 marks)

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QUESTION 4 [25 marks]

(a) Figure 3 shows a phase shift oscillator circuit which can accommodate an oscillation of 1 kHz.

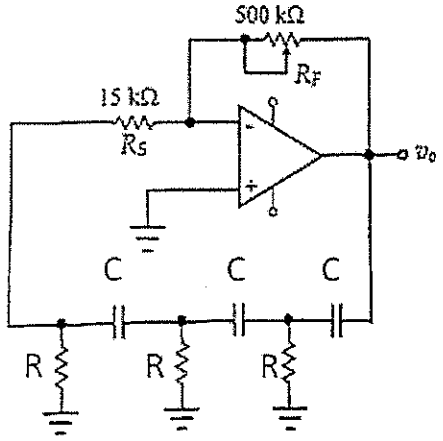

Figure 3

Based on the Figure 3, calculate the following:

i) Resistor value in the RC circuit if $C = 100$ nF. (3 marks)

ii) The value of feedback resistor (R_F), that need to be adjusted by using 500 kΩ potentiometer. (2 marks)

(b) When the DC supply voltage changes from $V_{DC} = \pm$ 12 V to $\pm$ 10 V, the change in input offset voltage per unit change in the dc supply voltage is 1 mV. Calculate the power supply rejection ratio. (4 marks)

(c) Design an inverting schmitt trigger comparator with the $V_0 = \pm$12 V, V_{UTP} = +7 V, V_{LTP} = -5 V. Assume that R_1 = 100 kΩ. Then sketch the complete circuit diagram with its input and output waveforms respectively. (16 marks)

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APPENDIX

Biquadratic voltage transfer function

Filter type	k_o, k_1, k_2	Voltage transfer function
Low-pass	1, 0, 0	$H_{LP}(s)=\frac{K\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
High-pass	0, 0, 1	$H_{HP}(s)=\frac{Ks^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-pass	0, 1, 0	$H_{BP}(s)=\frac{K(\omega_o/Q)s}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-reject	1, 0, 1	$H_{BR}(s)=\frac{K(s^2+\omega_o^2)}{s^2+(\omega_o/Q)s+\omega_o^2}$
All-pass	1, -1, 1	$H_{AP}(s)=K\frac{s^2-(\omega_o/Q)s+\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$